anatomic expressions of reconstructed organs and of altered organ relations.

It has been said that the days of morphological investigation are over. I trust I have, although inadequately, indicated, that cultivation of morphology is as important for scientific vision today as it has been in the past and how much still remains here to be done.

THE TRANSFUSION OF BLOOD WITH REPORT OF 186 TRANSFUSIONS.

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The brilliant results of human blood transfusion during the past few years and the ease with which this operation can be performed by any one of a number of modern methods has made it one of the most frequent procedures in practical medicine and surgery.

History. The early literature on the subject of transfusion is rather indefinite. In the year 1492 an attempt was made to prolong the life of Pope Innocent VIII by transfusion, which was unsuccessful. The lives of three donors were sacrificed in the attempt. A. H. Matthews, in the *Life and Times of Rodrigo Borgia*, flatly denies this occurrence. There are no convincing records of any transfusion being done before William Harvey's important discovery of the circulation. It was not until 1616 that Harvey presented his views to the College of Physicians, and it was 1628 when he published his treatise on *Motion of the Heart and Blood*.

Mention is made of transfusions by an Italian physician, Francesco Folli, in 1654, and by Daniel of Leipsig in 1664; but most historians give the credit to Wren of conceiving the idea of using infusions in bloodvessels and to Richard Lower, of England, and Jean Denys, of France, of being the first to really carry out the procedure. Lower carried out the first transfusion experimentally on dogs in 1665, and in 1666–7 Denys first successfully transfused a man by using lambs' blood. Lower used a cannula and connected the artery of one animal to the vein of another.

Samuel Pepys, on November 14, 1666, recorded in his diary that "at a meeting of Gresham College . . . the experiment of transfusing the blood of one dog into another was made before the society by Mr. King and Mr. Thomas Coxe upon a little mastiff

and a spaniel, with very good success." On November 21 he records that "the spaniel was produced and found very well." Again, on November 21, 1667, Pepys wrote of a "Poor and debauched man that the college had hired for twenty shillings to have some of the blood of a sheep let into his body . . . their purpose to let in about twelve ounces, which they compute is what will be let in in a minute's time by the watch." This was probably the first human transfusion done in England. It was accomplished by means of a cannula, at a meeting of the Royal Society at Gresham College, on November 23, 1667. The transfusion, according to Pepys was evidently successful.

There then followed many years of use and disuse, of success and failure. Animal to animal, animal to man and man to man methods were attempted. Some were done by means of a cannula, but the majority were done by the indirect method. That the failures were far greater than the successes can be seen in the action of the French Government, which forbade the procedure until the Faculté of Paris should give its approval.

Blundell, in 1817, reported seven cases of transfusion with human blood done for postpartum hemorrhage, three of which resulted in recovery. His apparatus consisted of a syringe connected by a two-way stopcock to a receptacle and to a tube, in turn connected with a cannula for insertion into the vein of the recipient. He had no means of preventing clotting. He reports that Goodridge used this method before him.

Sheele, in 1802, and Diefenbach, in 1828, wrote extensively on the subject of transfusion. Dumas and Prevost, in 1821, first showed the injurious effect of injecting the blood of an animal of one species into that of another. In 1835 Bischoff introduced the method of defibrination, and in 1848 Diefenbach also advised this method. Later Panum, Prevost and Brown-Séquard, after numerous experiments, decided that the process of defibrination was the chief factor in the performance of a successful transfusion. In 1863 Blasius reported 116 transfusions, all done in the previous forty years, 56 of which were successful. All of these were indirect transfusions. Two were from animals and were reported as successful. Fourteen cases were done with undefibrinated blood, all of which were unsuccessful. During the Franco-Prussian War, 37 transfusion were reported. All of these were done with defibrinated blood, and 13 were successful. Geselius and Hasse, in 1874–1875, respectively advised the use of animals' blood for transfusion, lambs' blood generally being used. No attention was paid to any reactions which would at this present day attract our immediate attention.

From 1863 to 1884 transfusion was supposed to be a "cure-all," and the claims made for it were preposterous. It was not until Landois, in 1875, demonstrated that the red cells of one species

when injected into a different species of animal are destroyed that all attempts at transfusing with heterogeneous blood cells were discarded. Panum, Landois and numerous other writers noted that blood of the same species might functionate normally if used for transfusion.

It was not long before the inadvisability of using defibrinated blood was discussed. Magendie, in 1838, noted several of the untoward effects after its use. Köhler, in 1877, made the important observation that the use of defibrinated blood or serum, even from animals of the same species, increased the danger, because of the excess of fibrin ferment injected, and therefore the increased tendency to intravascular clotting. Landois, Geselius and Ponfick agreed with this. Colnheim, in 1883, in reviewing the literature, stated that it was inexcusable to use any blood for intravenous injection in which clotting had already taken place. But until von Bergemann, in 1884, published his important work, transfusion was still a subject of great interest. He reviewed the entire literature and came to the conclusion that the only reason there were not more fatalities was because in most cases not enough fibrin ferment had been introduced to produce extensive intravascular clotting. He came to the conclusion that the only permissible transfusion was the direct one from artery to vein. Such death-blows to a process already on the wane because of the frequency of its disastrous results, together with the fact that the use of saline solutions for intravenous injection was becoming more general, caused the transfusion of blood to be abandoned as a therapeutic measure.

From that time up to the beginning of the present century, transfusion is only rarely mentioned in the literature, and then chiefly as a matter of historic interest. In 1898, Crile, of Cleveland, began a series of experiments which marked the introduction of transfusion as a safe and valuable therapeutic procedure. He began by using arteriovenous suture, which came into existence through the work of Payr and Murphy. He later adopted the ring-cannula method, first suggested by Nitze in 1897 and carried out by Payr in 1900. Jensen, in 1903, experimented with several methods, and in his report favored suture technic. Höpfner, in von Bergemann's clinic, in 1903, used the ring method in twenty-eight cases and concluded that it was not applicable to vessels smaller than 3 mm. in diameter. The technic of vascular anastomosis became so perfected through the work of Carrel, of the Rockefeller Institute, that this method, in the hands of men experienced in bloodvessel surgery, came into vogue. In 1907, Watts reported four cases by this method. Crile's cannula method, as well as Carrel's method, presented so many technical difficulties for the average surgeon that other methods were sought for. Crile's cannula was modified by Janeway, Elsberg, Soresi, Bernheim and Levin. Elsberg's modification was undoubtedly the best.

Then in rapid succession followed the glass-cylinder method first advocated by Kimpton and Brown in 1913 and later by Vincent and Percy, with their modifications. After this, in 1913, came the syringe-cannula method of Lindeman. Ziemssen used this method twenty years before, but it never became popular until revived by Lindeman. After this, in 1916, came the simultaneous work of Lewisohn and Weil in this country, of D'Agote in Buenos Ayres and of Jeanbrau of Montpelier on the use of sodium citrate as an anticoagulant. Heretofore hirudin, ammonia and oxalates had been advised and used as anticoagulants, but each in turn had been discarded. The work of these four men reopened the entire subject of transfusion. At this same time (1916) Satterlee and Hooker described their pipette-cannula method.

Since then the modifications have been too numerous to mention. Brenziger, Martin and Lee, and Unger have described useful modifications. The chief fact to come out of all the recent work, however, is the fact that nearly all the blood from donors can be obtained by the needle, using one of the many described, and that in at least a large percentage of cases the blood can be given by the needle, thus avoiding the destruction of a useful vein.

Indications. Now that the initial enthusiasm for a newly rediscovered procedure is over we are better able clearly to define the indications for transfusion. As Bernheim has said, the indications depend upon the surgeon's knowledge as to "when the limit of bleeding has been reached; and by the limit I refer to progressive anemia of any sort, from any cause."

We have found the indications divisible into three groups, and increased experience in the procedure will give the clinician definite ideas of the types of cases which will benefit by it.

I. *Loss of Blood.* To this group belong all those cases of anemia from acute hemorrhage as well as those cases due to small, long-continued blood losses. Some of the latter, however, finally fall into the second group.

II. *Diseased Blood.* Transfusion for this group serves the following functions:

1. To stimulate hematopoietic function.
2. To increase coagulability.
3. To add to the oxygen-carrying capacity.
4. To increase the bactericidal or antitoxic properties of the blood.
5. To increase the general nutrition.

III. *Shock.*

I. Loss of Blood. 1. Blood transfusion is invaluable in acute hemorrhage after injury or operation. In this group belong the hemorrhages of childbirth, ectopic gestation, miscarriages, fibroids and other uterine hemorrhages. Acute bleeding from injuries, from gastric, duodenal or intestinal ulcers, and from rup-

tured viscera belongs here also. It is in these cases of acute massive hemorrhages that the surgeon sees the most miraculous results. One of our cases admitted cold, pulseless and unconscious after a crushing injury to the thigh was revived by transfusion of 2100 c.c. of citrated blood. These cases can be operated on much more safely and the convalescence is much more rapid with a transfusion than without. The average amount of blood which we use for transfusion in acute hemorrhage is 750 to 1000 c.c., although, as noted above, one of our cases had 2100 c.c. This, however, was distributed over a period of twelve hours. Free blood in the abdominal cavity, if uncontaminated, can be filtered and citrated and used to transfuse the patient.

The question as to when to transfuse for acute hemorrhage depends upon the surgeon, but we believe that if all borderline cases were transfused the mortality from acute hemorrhage would be less. A pale, cold, clammy patient, with a weak, rapid and thready pulse, dyspneic and often cyanotic, with a low red cell count and hemoglobin and a systolic pressure of eighty or below, should be transfused as soon as a suitable donor is found. This will not only make up for the blood loss but it will also undoubtedly help to check the hemorrhage, provided the amount of blood given is not too large or given in too short a time.

2. In the repeated small hemorrhages the anemia may become so aggravated that the blood picture will simulate that of a primary anemia. Transfusion before the hemorrhage is controlled, and after this until the blood picture again assumes a somewhat normal appearance, act nearly as specifically as in the first group. In cases of chronic bleeding the coagulation mechanism becomes deranged and the longer the bleeding continues the less likely it is to stop spontaneously, although the coagulation time of the blood outside of the body is but little delayed.

In these cases we transfuse repeatedly once or even twice a week, until the blood picture shows that the blood-forming organs are again functioning normally. In this way an apparently poor surgical risk may be turned into a good one.

II. Diseases of the Blood. Here the new blood acts as a therapeutic agent.

(1) Hematopoietic Function. In this subsection belong the primary anemias and extreme secondary anemias. The transfusion is done with the hope that it will stimulate hematopoietic function. This probably occurs through the products of blood disintegration which stimulate the bone marrow. Several transfusions are necessary and it is often noted that the second transfusion is of much more benefit than the first. In this type of case we welcome a moderate reaction, since these patients seem to get the best ultimate results. For this reason some writers advise small doses of incompatible blood.

(*a*) Primary Pernicious Anemia. Vogel and McCurdy in 1913 first carefully studied the effect of blood transfusion and regeneration in primary pernicious anemia. In our series of cases we find that, while transfusion is of no permanent value, by repeated transfusions we have prolonged a patient's life for as long as four years. This patient has had sixteen transfusions, in this period, and is still able to go about. We feel that transfusion offers more for pernicious anemia than any other form of treatment. The remission which is brought about comes sooner and lasts longer, as a rule, than one occurring under medical treatment alone, and the life of the patient may be saved for some years.

If a remission is not brought about it is well to change donors. In this way results can be obtained by transfusion which make it superior to any other therapeutic measure. The important thing to remember is that under no circumstances should the patient be allowed to become so weak that transfusion is a dangerous procedure, but when the red cells continue to decrease and the hemoglobin reaches 30 it is time to begin transfusions.

(*b*) Aplastic Anemia. Here there is no tendency to blood regeneration, the leukoblastic and erythroblastic activity both being demoralized. Although blood transfusion does not even cause a remission in these cases, rapidly repeated transfusions (twice a week) will so increase the number of blood cells and hemoglobin, and relieve the symptoms that the patient can carry on his affairs for a variable period, though never a long one.

(*c*) Splenic Anemia. In this group we include splenic anemia and Banti's disease. Transfusion plus splenectomy offers the best opportunity for obtaining a cure. If the blood count is low after operation the transfusion may be repeated in order to give the blood-forming organs an impetus to resume their normal function.

(*d*) Leukemia. In our series we have had only one case of leukemia, that being a case of acute lymphatic leukemia. He was transfused four times, within ten days, with a total of 2200 c.c. of blood. When he was admitted his blood count was R. B. C., 905,000; W. B. C., 31,400; Hb., 25 per cent. On discharge his count was R. B. C., 3,600,000; W. B. C., 45,000; Hb., 33 per cent. However this improvement was only short-lived and an acute exodus followed soon after discharge. This is often the case and the most we can hope to do is to attempt to tide the patient over until the disease takes on a more chronic form and other treatment can be begun.

(*e*) Hemolytic Ictero-anemia. In this condition transfusion does not offer permanent relief but is of value in improving the anemia enough to warrant the operation of splenectomy, which is possibly a curative measure. Transfusion following the operation shortens convalescence and hastens the return of a normal blood picture.

(2) To Increase Coagulability. To this group belong the cases of (*a*) melena neonatorum, (*b*) hemophilia, (*c*) jaundice, (*d*) purpura, (*e*) secondary hemorrhagic diseases complicating such conditions as grave anemias, leukemias, and severe infections. It is in these hemorrhagic diatheses that we find the results of blood transfusion uniformly good. Melena neonatorum and hemophilia usually yield as if by magic to a single transfusion, although transfusion does not confer immunity to hemophiliacs against further hemorrhage. Citrated blood is just as efficacious in these cases as is unmixed blood. This has been definitely proved by Pemberton. If the first transfusion has not the desired effect, then a second one should be done with a different donor. Temporizing with less effective measures, as horse serum and various coagulants, may cost a life.

In our series we include a case of cholemia following cholecystectomy in which the patient had a number of fairly large hemorrhages. Her condition had become very serious when we decided on blood transfusion. There was immediate improvement in the patient's general condition and there were no further hemorrhages.

(3) To Increase the Oxygen-carrying Capacity of the Blood. Here belong the cases of illuminating gas-poisoning. Only a few cases have been reported. Carbon monoxide has a stronger affinity for hemoglobin than oxygen. When carbon monoxide combines with the hemoglobin the red corpuscle is removed from the circulation as effectively as in acute hemorrhage, as far as its oxygen-carrying capacity is concerned. The patient should be bled at the time of the transfusion. This may be difficult because the blood often becomes of a syrupy consistency. Our series of cases does not include any of this type.

(4) To Increase the Bactericidal and Antitoxic Properties of the Blood. Transfusion has no place in the acute infections unless the so-called "vaccination transfusions" suggested by Heyd and Hooker, that is, transfusion with immunized blood, open new possibilities. There is however, a large group of cases suffering from sub-acute and chronic infections which is materially benefited by transfusion. These cases, as a rule, are profoundly anemic, and transfusion should not be delayed until the body has lost its power of reaction. The transfusion is a stimulant to the hematopoietic organs, throws into the circulation functionating corpuscles and at the same time probably contains antibodies which may affect the life of the organism causing the infection, or so stimulate the patient's forces as to help them to develop an active immunity. Cases of chronic suppurating wounds do more than justify the procedure. We have used it in chronic suppurative disease of the hip-joint and in malignant endocarditis. The results would seem to justify further trial.

Antitoxie. For its antitoxie effect transfusion is of use in the toxemia of pregnaney with doubtful results, and in sprue, purpura and pellagra. While the beneficial effect is undoubted in purpura, in the other conditions the results are as yet doubtful. Lindeman reported four cases of tropical sprue treated by transfusion, with apparent recovery in every ease. In the toxemia of pneumonia transfusion has been used with questionable results. Our only ease, in extremity when transfused, died.

(5) As a Stimulant in the Various Cachexia. Here the transfusion is used for its general nutritive effect. It improves the vitality of the tissue eells. It frequently will permit radical operative procedure which before transfusion would have been out of the question. In debilitating conditions such as careinoma it will improve the patient's general condition and prolong life. A field open to its use is the malnutritions of childhood, especially marasmus, and cachexia from prolonged diarrheas.

III. Shock. The value of transfusion in shock, especially if associated with hemorrhage, has received so much attention recently that it is needless to discuss it further here. It is just as useful in civilian as in military practice. In the eases of shock without hemorrhage, however, we must not expect as brilliant results as in those associated with hemorrhage. If an operation is necessary the patient who has been transfused is better able to stand the shock due to additional trauma.

DIAGNOSIS OF PATIENTS TRANSFUSED.

Pernicious anemia	32
Aplastic anemia	9
Hemolytic icteroanemia	2
(*a*) Both splenectomized.	
Splenic anemia	3
(*a*) Two spleoectomized.	
Acute leukemia	1
Secoodary anemia	4
Acute hemorrhage and shock	19
Acute infectioos	4
(*a*) Peritooitis.	
(*b*) Pneumonia.	
(*c*) Brain abscess.	
(*d*) Streptococcemia.	
Cachexia and chronic infections	8
(*a*) Marasmus (2).	
(*b*) Nephritis, chrooic (2).	
(*c*) Hip-joint disease (3).	
(*d*) Infectious endocarditis (1).	
Carcioooma and sarcoma	2
Hemophilia	3
(*a*) One case of cholecoia.	
Total	87

Amount of Blood to be Transfused. The amount of blood to be transfused depends upon two factors: first, the indication, and

second upon the receiving capacity of the recipient. The latter depends upon the condition and size of the patient. In cases of severe acute hemorrhage transfusions of large amounts of blood are indicated. We have given as much as 2100 c.c. in a period of twelve hours. This amount is often difficult to obtain but 1000 c.c. can be taken from a donor in good physical condition without any risk. In cases of secondary, primary pernicious or aplastic anemia we usually use 500 c.c. although if the transfusions are not at very frequent intervals we use 750 c.c. In primary pernicious anemia if the blood count is fairly high and the transfusion is given to stimulate blood formation small transfusions, as 250 c.c., are as efficacious as larger ones. In hemophilia 250 to 500 c.c. are sufficient. In melena the size of the transfusion varies from 10 to 100 c.c. Whole blood is most frequently given intramuscularly in this condition.

The fate of the transfused blood has recently been determined by Ashby. He sums up his conclusions by saying "The life of the transfused corpuscle is long; it has been found to extend for thirty days or more. The beneficial results of transfusion are without doubt not due primarily to a stimulating effect on the bone-marrow, but, it is reasonable to assume, to the functioning of the transfused corpuscles."

Selection of Donors. In choosing donors for the transfusion three laboratory tests are necessary: the Wassermann reaction, a blood count, and typing. In an emergency the first two may be omitted, but under no circumstances the last. Even in children, when a parent is the donor it is a wise precaution to take, although Kimpton states that children under two probably belong to no group. Cherry and Langrock have proved in a series of 34 cases that all mothers can be used as donors in transfusions of their newborn infants; and Kimpton says in thirty transfusions with only two exceptions he has used the father. Pemberton, however, states that the infant develops its own group after the first few weeks. The donor should be a robust young adult, with a negative Wasserman reaction and negative venereal history, and a blood count that is high normal. He must be either in the same type group as the recipient or in group IV.

The interaction of the donor's and recipient's cells and serum may be determined by the crossed hemolysis tests, and these tests must be carried out in all cases where the type reading is doubtful. The simple typing with known sera has proved so satisfactory if accurately done that only in a few cases have we used any other methods for determining the suitability of a donor's blood. The method of Vincent, based on the grouping of Moss, is the one which has been used in most of our cases. A drop of known type II serum is placed on one end of a clean slide and a drop of known type III serum on the other end. One drop of the patient's blood is then mixed with each drop of serum. The slide is rocked from side to side gently

for five minutes and then examined for agglutination. The type is determined by the following table:

Serum	I	II	III	IV
Groups I	−	−	−	−
Group II	+	−	+	−
Group III	+	+	−	−
Group IV	+	+	+	−

Moss has found in extensive observations that agglutination frequently occurs without hemolysis, but that hemolysis is always associated with or preceded by agglutination. If crossed hemolysis is done we use a modification of Rous' method of testing donor's blood for transfusion. Take two small test-tubes (1 x 5 cm.); in each place four drops of the following citrate solution:

Sodium citrate	1.5 gm.
Sodium chloride	0.9 gm.
Distilled water	100.0 c.c.

In one tube collect from the finger or ear one drop of the donor's blood and nine drops of the recipient's blood; in the other tube, one drop of the recipient's blood and nine drops of the donor's blood. Mix by shaking. Allow to stand for fifteen minutes. Take out a drop from each tube and place on a slide. Add a large drop of normal salt solution without mixing. Cover and examine under the microscope for agglutination. If desired, two drops of citrate solution and one drop of blood may be mixed in a third tube, as a control.

If there is no agglutination in any mixture, the transfusion is safe. If clumping is present in the tube containing nine drops of recipient's blood and one of the donor's, the recipient's blood agglutinates and may hemolyze the donor's blood and transfusion is dangerous. If clumping is present in the tube containing nine drops of donor's blood and one of recipient's it indicates that the donor's plasma agglutinates the recipient's cells. Transfusion under these circumstances is permissible since the donor's plasma is so diluted as to have little hemolytic power, but it is less desirable than where no agglutination is present.

Method. The method we describe here is the one in use at the University Hospital. After a donor has been selected he is placed on an ordinary operating-room table. The selection of the arm to be used depends upon the donor's choice and upon the suitability of the veins for use. The arm is extended and placed on a small table. The site is cleansed with a 95 per cent. solution of alcohol and then painted with a 5 per cent. solution of picric acid. A tourniquet is applied and sterile sheets are placed so as to surround the operative field.

A short length, large calibre aspirating needle is used to remove

the blood. We find this as efficient as any special needle designed for this purpose and the cost is considerably less. The needle is inserted into the vein against the current and the blood is collected in a suitable Erlenmeyer flask, which at the start contains one-half of the total amount of sterile sodium citrate solution to be used. We use enough of a 2.5 per cent. solution to make the end-result 0.25 per cent. While the blood flows into the flask the remainder of the citrate is dropped in with it by means of an ordinary pipette. The flask should be gently shaken during the collection of the blood (Fig. 1).

After the blood is collected the tourniquet is loosened and the needle removed. A small pressure bandage is applied. The flask containing the blood is inverted three or four times and then placed in a basin of water, the temperature of which is 120° F.

FIG. 1.

The recipient's arm is prepared in a similar manner, a tourniquet is applied, and if the vein is of sufficient size to allow it, a needle is used to introduce the blood (Fig. 2). If the vein is not large enough it is necessary to cut down on it and insert a glass cannula. This is, of course, less desirable where repeated transfusions are necessary because it destroys the vein for further use below this point. The skin is first infiltrated with a sterile solution of 0.5 per cent. novocain. The incision in the skin seldom needs to be longer than 1.5 cm. The vein is isolated by blunt dissection with a mosquito hemostat which is then inserted under the vein to carry the catgut ligature. The vein is tied off at its distal end while the ligature at the upper end is merely looped. Sharp-pointed scissors

are used to nick the vein in an oblique direction. A mosquito hemostat is applied to either side and to the apex of the triangular nick. While this is being done the assistant holds the proximal ligature taut so as to prevent unnecessary bleeding. The blood is introduced by gravity. A 250 c.c. cylinder containing a small amount of normal sodium chloride at 100° F., is used. The cannula is inserted into the vein in the direction of the flow as soon as all air has been excluded from the apparatus and the flow of saline is

FIG. 2.

established. The tourniquet is now removed. The blood is poured into the cylinder, being filtered through several layers of gauze which have been placed over the top of the cylinder. Even though the blood has been typed and a crossed hemolysis has been done we stop the flow after the introduction of the first 25 c.c. to see if any immediate reaction occurs. If there is any reaction at this time the transfusion is stopped. The blood in the cylinder should be at a temperature of 110° F. and this may be accomplished by keeping the flask in a basin of water at 120° F.

After the blood has been introduced we again run in a small amount of sterile normal saline. The upper ligature on the vein is tied as the cannula is removed. The skin incision usually needs but one vertical mattress suture. In women accustomed to wearing short sleeves it is preferable to use the internal saphenous vein. This can be used for repeated transfusions, especially if the first incision is just above the internal malleolus.

When the vein is of sufficient size the same type of needle is used as that used in withdrawing the blood from the donor. It is inserted in the direction of the blood current. After the apparatus is prepared as above it is connected with the needle by a connecting piece.

In infants we have used the superior longitudinal sinus for the introduction of the blood. It is a very simple procedure and no untoward results have been observed.

Our series includes one arteriovenous suture, 47 transfusions by the Kimpton-Brown Method and 138 by the citrate method. We now use only the citrate method and consider this the procedure of choice. It is easy, safe, and as reliable as any method yet described.

REACTIONS.

None.	Mild.	Moderate.	Severe.	Death.
127[1]	45	9	3	2[2]

In properly typed individuals there should be no mortality unless the transfusion is attempted as a heroic measure in a patient who otherwise has no chance at all.

In an emergency where time means all and the typing sera are not obtainable 15 to 25 c.c. of the donor's blood may be injected into the recipient's circulation. If no symptoms occur within three to five minutes, the transfusion may be continued.

The symptoms of incompatibility are: (1) Dyspnea, (2) pain in the back, (3) abdominal discomfort and even pain associated with nausea and vomiting, (4) dilatation of the pupils, (5) sweating and flushing of the skin, (6) vertigo and throbbing headache, (7) puffiness of the face and eyelids.

Ottenberg and Kaliski report that in 10 per cent. of their cases "febrile reactions or urticaria and other skin eruptions occur." These they say are irrespective of hemolysis or agglutination and are probably due to fibrin ferment or blood platelet destruction. Two of the patients in our series developed herpes facialis the day following transfusion. A third patient repeatedly developed a

[1] A slight temperature with no subjective symptoms has been considered by us as no reaction.

[2] One by Kimpton-Brown method and one by citrate method. The deaths were both in cases of pernicious anemia. Since the writing of this paper one of the authors has had a mortality in another patient suffering from the same condition. The bloods were typed and cross-hemolyzed. The patient's condition, however, was most unsatisfactory. The temperature was 107° within six hours after transfusion and he died within twelve hours.

severe and annoying itching after each transfusion. Two developed bleeding from the gums with no other demonstrable symptoms except abdominal pain. Both of these recovered. In the serious cases jaundice and hematuria are evident if the patient lives long enough. Bernheim in 1915 in reporting 800 transfusions by 12 operators, found hemolysis in 15 cases with four deaths. Pemberton in reporting 1036 transfusions found 12 cases in which there were reactions, attributed to clerical errors in recording the grouping.

Meleny, Stearns, Fortuine and Ferry in a study of 280 transfusions find that the more transfusions a patient is given the more likely he is to have a reaction, especially if the same donor is used a large number of times.

The temperature after the citrate transfusions has gone up as high as 104° F. It sometimes goes down in a few hours by a form of crisis, other times it takes two or three days to reach normal.

Mortality due to transfusion—1.09 per cent. It should be stated here that there have been more deaths in the series, but these occurred some time after the transfusion and therefore must be attributed to other causes.

Mortality figures are of little value unless it can be shown that death resulted from hemolysis or agglutination directly after transfusion because this is an emergency measure in many cases and death may result from the condition for which transfusion was done.

CONDITIONS OF PATIENTS WHEN LAST HEARD FROM.

	Unimproved.	Improved.	Cured.	Died.
Primary pernicious anemia	1	23	0	7
Aplastic anemia	4	3	0	2
Secondary anemia	0	5	0	1
Acute leukemia	0	0	0	1
Hemolytic-ictero anemia	0	0	1	1
Hemophilia including case of cholemia	0	2	1	0
Splenic anemia	0	0	2	0
Acute infections	0	0	1	3
Cachexia and chronic infections	0	6	0	2
Acute hemorrhage and shock	0	0	14	5
Carcinoma and sarcoma	0	1	0	1
Total, 87.	5	40	19	23

These records are not as accurate as they should be since there is no systematic follow-up procedure in the hospital. However some of the patients have been seen or heard from several years after their discharge from the hospital.

Conclusions. 1. With the element of risk practically eliminated blood transfusion has become one of the most effective procedures in modern therapeutics.

2. Transfusion is a specific in acute hemorrhage where the

"limit of bleeding" has not been reached, in melena and in the hemorrhage of hemophilia.

3. It is of definite value in primary pernicious anemia in hastening and prolonging remissions. It is indicated in cases of severe secondary anemia. After transfusion operations on debilitated or anemic individuals may often be safely undertaken that otherwise would involve serious risk.

4. Transfusion in shock is not as efficacious as in cases of shock associated with hemorrhage.

5. We have not been able to prove the value of transfusion in acute infections, but in chronic infections we have had results justifying its use.

6. Transfusion is of unproved value in acute leukemia. In aplastic anemia it is at the most a temporizing proceedure.

7. The difference, as far as reactions are concerned, between the citrate method and the Kimpton-Brown method we have found to be practically nil and the simplicity of the former warrants its preference.

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